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TRAPPING EXPERIMENTS FOR THE CONTROL OF THE CIGARETTE BEETLE[1]

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INTRODUCTION

The cigarette beetle (*Lasioderma serricorne* Fab.) can be controlled in closed tobacco warehouses by fumigation.[2] In the Bright Tobacco Belt, however, it is estimated that more than 350 million pounds of flue-cured tobacco, or probably 50 percent of the total quantity of leaf tobacco stored, is held in open storage (fig. 1), and this type of warehouse has never been fumigated successfully. It was therefore imperative that control measures be developed for tobacco in open storage.

The Bureau of Entomology laboratory at Richmond, Va., has been engaged in research on this problem, and during 1932 and 1933 various devices using light to attract the beetles were tested. The most promising device was a trap utilizing the combination of suction and light developed in 1932 and tested in warehouses in Virginia, with the cooperation of the tobacco industry. A description of this trap and the data on the experiments in 1932 have been published.[3] Experiments with these traps were continued in 1933, and the results are presented in this circular, as a progress report of the work, which is to be continued.

THE SUCTION LIGHT TRAP

Because of the favorable results obtained with this trap in 1933, it is considered desirable to describe it in more detail.

[1] This investigation was conducted under the direction of Dr. E. A. Back.

[2] Reed, W. D., Livingstone, E. M., and Morrill, A. W., Jr. The fumigation of tobacco warehouses. U. S. Dept. Agr., Bur. Ent. and Plant Quarantine, Multigraphed Circ. E-325, 12 pp., illus. 1934.

[3] Reed, W. D., Morrill, A. W., Jr., and Livingstone, E. M. Experiments with suction light traps for combating the cigarette beetle Jour. Econ. Ent. 27: 796-801, illus. 1934.

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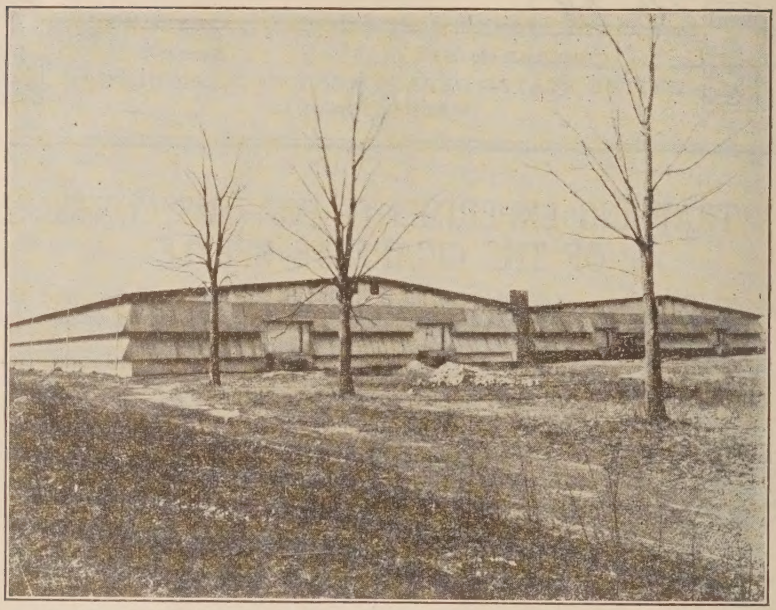

FIGURE 1.—Open-storage tobacco warehouse. The walls are constructed of sheet metal, roof of asphalt and gravel, and floor of wood. This type of warehouse cannot be fumigated effectively.

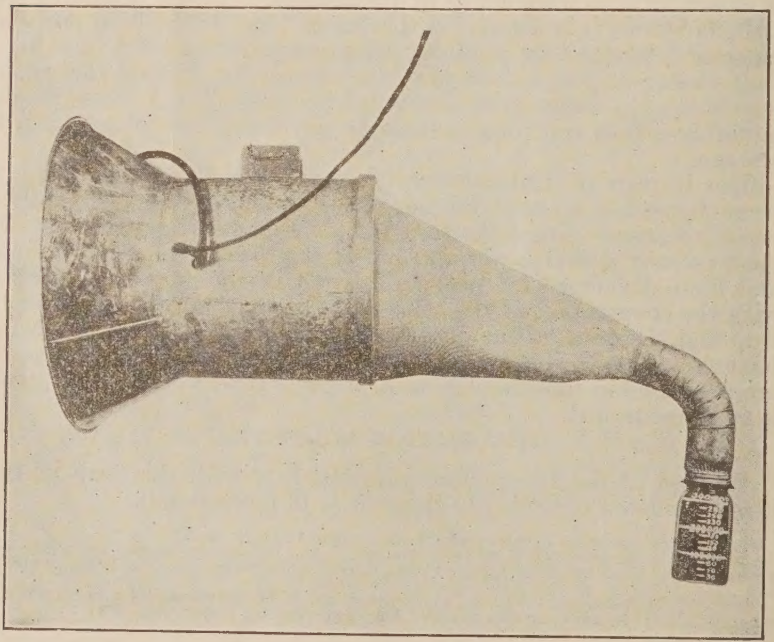

FIGURE 2.—The suction light trap, showing the reflector, barrel, wire cone, and glass jar. The motor is attached to a crossbar in the barrel, as indicated by the wiring. The 1-quart jar has a capacity of approximately 300,000 cigarette beetles.

The suction light trap consists of three main parts, the flange, the barrel, and the cone (figs. 2 and 3). The flange, made of block tin,

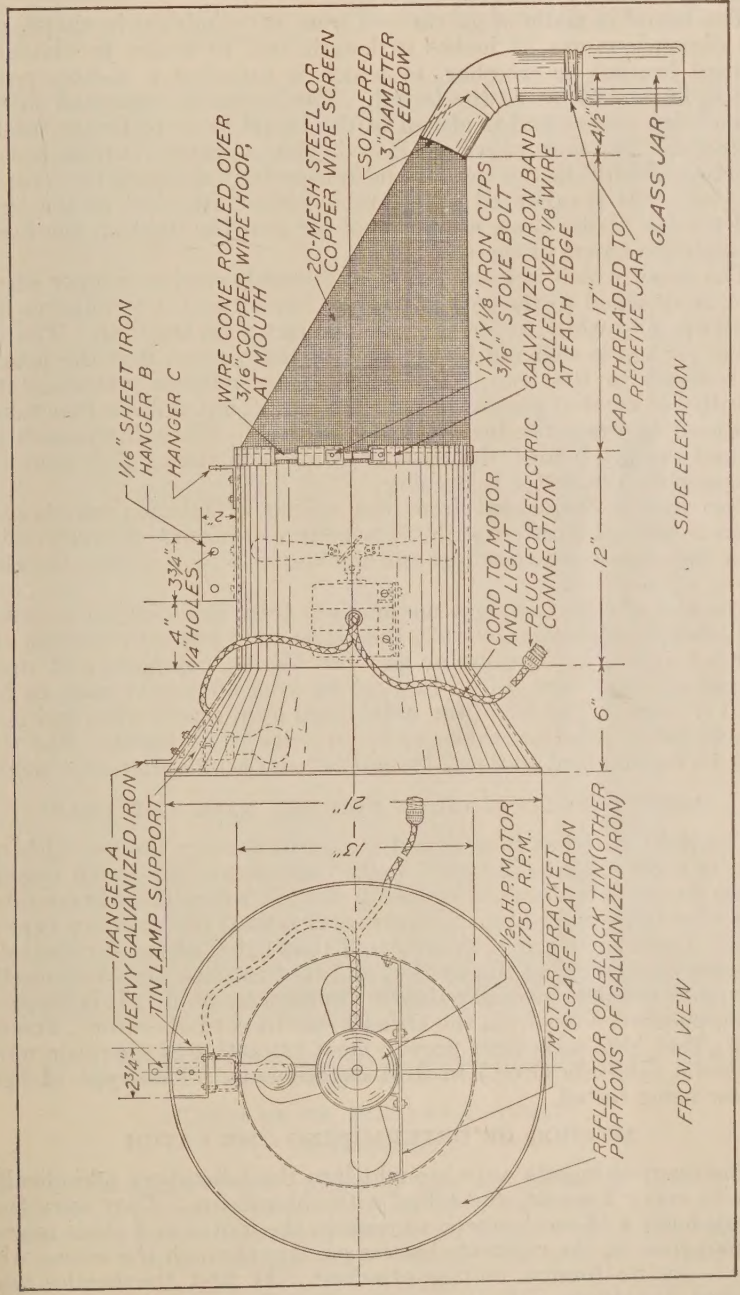

FIGURE 3.—Working diagram of the suction light trap.

is 21 inches in diameter at the outer edge and 12½ inches where it is soldered to the barrel of the trap. The flange supports a socket

from which hangs an electric light, and it serves to increase the flow of air through the barrel, and also to reflect the light, thereby increasing the effectiveness of the trap.

The barrel is made of galvanized iron, is cylindrical in shape, and the dimensions are 12 inches in length and 13 inches in diameter. A steel bracket or crossbar, to which is attached a 1/20-horsepower motor, is riveted inside the barrel. The motor is connected to two 12-inch fan blades and is placed in the barrel so as to locate the fan centrally. The motor is of the closed type to prevent it from becoming clogged with dust or insects and is especially designed for continuous duty. It is operated on a double socket attached to the light, and the fan blades draw a current of air past the light on the flange through the barrel of the trap.

The cone, which is constructed of 20-mesh steel or copper screen wire, is attached to the rear end of the barrel, and it terminates in a small opening which accommodates a quart glass fruit jar. The rim of the jar top is soldered to the neck of the cone so that the jar can be screwed to the trap. The screen cone reduces materially the quantity of air that passes through the barrel, but sufficient suction is produced to draw the beetles into the trap. When the insects get beyond the fan blades, the current of air is so strong that none can escape while the motor is running.

The trap is suspended from the ceiling of tobacco warehouses, where it will not interfere with the regular operations. Usually once a week the traps were examined and the beetles removed from the glass jars.

The cost of constructing a suction light trap, including all materials and labor, is approximately $20 (based on 1934 prices in Virginia and North Carolina). The motor and fan blades, complete and ready for installation, were priced in 1934 at from $9 to $11 each in lots of 10 or more. The block tin, galvanized iron, screen wire, and glass jars varied in price according to the quantity purchased. The trap may be constructed by local tinsmiths from a blueprint or a model.

MOST EFFECTIVE LIGHT FOR USE WITH THE TRAP

The light that has been found most satisfactory for use with the trap is a 50-watt "mill-type" bulb, constructed for rough service. These lamps were designed especially for use where there is considerable vibration, and will give longer service than the ordinary type of bulb. Experiments in 1933 indicated that lights of greater intensity than 60 watts repelled the beetles, and that catches were also smaller when lamps of less intensity than 40 watts were used. It is reported in unpublished notes from the Dried Fruit Insect Laboratory, Fresno, Calif., that blue neon light proved most attractive to the raisin moth (*Ephestia figulilella* Greg.) in field experiments. This type of light is now being tested.

METHOD OF DETERMINING THE CATCH

The trapped insects were brought into the laboratory periodically, usually every 2 weeks, and killed with chloroform. They were then run through a 14-mesh screen to remove the moths and other miscellaneous insects, the cigarette beetles passing through the screen with practically no foreign matter attached. At first the beetles were weighed to obtain a figure representing the approximate number

caught, but this method was abandoned because the beetles varied considerably in moisture content, and to dry them out in an oven required too much time. Measuring the beetles in calibrated glass containers (fig. 4), graduated from 500 to 500,000, was then tried and found to be satisfactory.

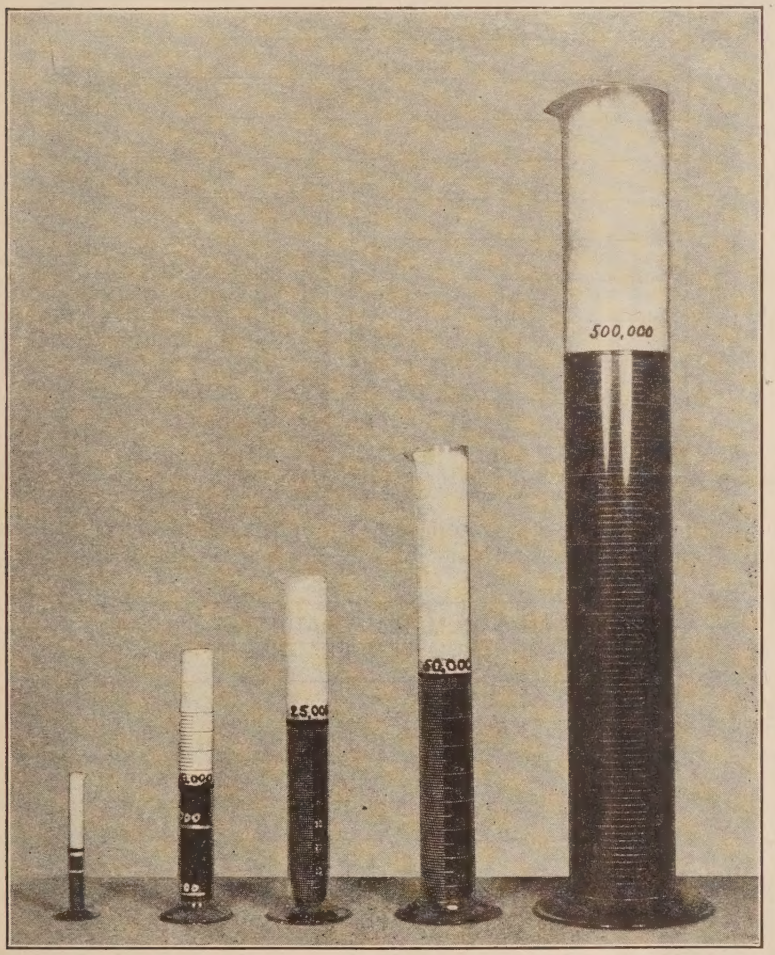

FIGURE 4.—Calibrated glass graduates used for determining the approximate number of cigarette beetles caught in the suction light traps. These graduates are calibrated as follows: 1,000, 10,000, 25,000, 50,000, and 500,000. The volume of 1,000 cigarette beetles is about 3 cc.

NUMBERS OF BEETLES CAUGHT

EXPERIMENT 1

In the first experiment trapping was conducted in warehouses containing Turkish tobacco totaling 1,105,000 cubic feet and in warehouses filled with domestic flue-cured tobacco totaling 4,199,000 cubic feet. These buildings were located near each other, and one trap was used for each 110,500 cubic feet of warehouse space. Ten

traps were run in the Turkish and 38 in the domestic storage warehouses. The traps were started in the Turkish storage on May 15

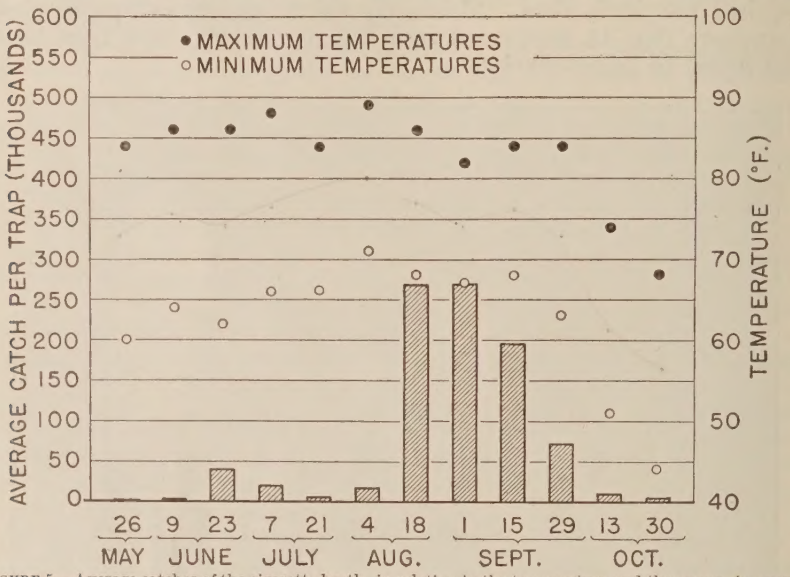

FIGURE 5.—Average catches of the cigarette beetle, in relation to the temperature and the season, in open-storage warehouses containing Turkish tobacco. Experiment 1.

and in the domestic storage on May 29, and were operated until the end of October. A summary of the catches is shown in table 1.

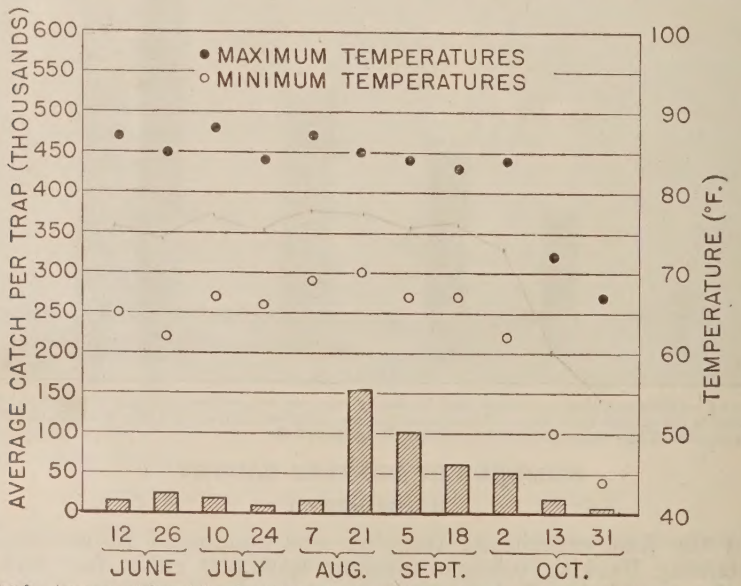

FIGURE 6.—Average catches of the cigarette beetle, in relation to the temperature and the season, in open-storage warehouses containing domestic flue-cured tobacco. Experiment 1.

The catches of cigarette beetles in relation to the temperature and season of the year are shown graphically in figures 5 and 6.

TABLE 1.—*Cigarette beetles caught in open-storage warehouses filled with Turkish and domestic tobacco, in relation to temperature and season, experiment 1, 1933*

Date	Interval	Beetles caught		Temperature		
		Total	Average per trap	Average maximum	Average minimum	Mean
	Days	*Number*	*Number*	*°F.*	*°F.*	*°F.*
TURKISH-TOBACCO WAREHOUSES—10 TRAPS STARTED ON MAY 15 [1]						
May 26	11	252	25	84	60	72.0
June 9	14	37,875	3,787	86	64	75.0
June 23	14	410,200	41,020	86	62	74.0
July 7	14	220,775	22,077	88	66	77.0
July 21	14	55,400	5,540	84	66	75.0
Aug. 4	14	186,230	18,623	89	71	80.0
Aug. 18	14	2,687,400	268,740	86	68	77.0
Sept. 1	14	2,701,700	270,170	82	67	74.5
Sept. 15	14	1,956,000	195,600	84	68	76.0
Sept. 29	14	730,700	73,070	84	63	73.5
Oct. 13	14	121,000	12,100	74	51	62.5
Oct. 30	17	65,900	6,590	68	44	56.0
DOMESTIC-TOBACCO WAREHOUSES—38 TRAPS STARTED ON MAY 29 [2]						
June 12	14	624,300	16,429	87	65	76.0
June 26	14	957,750	25,467	85	62	73.5
July 10	14	742,500	19,539	88	67	77.5
July 24	14	429,300	11,297	84	66	75.0
Aug. 7	14	688,000	18,105	87	69	78.0
Aug. 21	14	5,928,500	156,013	85	70	77.5
Sept. 5	15	3,945,000	103,816	84	67	75.5
Sept. 18	13	2,390,000	62,895	83	67	75.0
Oct. 2	14	2,019,000	53,132	84	62	73.0
Oct. 13	11	738,300	19,429	72	50	61.0
Oct. 31	18	306,000	8,053	67	44	55.5

[1] These warehouses consisted of 5 sections having a total of 1,105,000 cubic feet of space.
[2] These warehouses consisted of 19 sections having a total of 4,199,000 cubic feet of space.

These records show that the population of cigarette beetles was much greater in Turkish tobacco than in domestic tobacco. The largest catch in domestic tobacco, made between August 7 and 21, was an average per trap of 156,013 beetles, whereas in Turkish tobacco the largest catch, made between August 18 and September 1, averaged 270,170 beetles per trap. It appears from figures 5 and 6 that both temperature and season of the year affect the migration of cigarette beetles. The catches of the spring brood, present from May 29 to June 25, were low. The rapid increase in the numbers caught during August and September indicates that beetles of the second and third broods migrate to a greater extent than do those of the spring brood. Observations made in warehouses showed that cigarette beetles were inactive at temperatures below 60° F. If high temperatures alone were responsible for increased beetle migrations, it is believed that larger catches would be made in the traps during the emergence of the spring brood, for the maximum temperature was slightly higher at that time than in August and September, when the largest numbers were caught.

EXPERIMENT 2

For the second experiment the trapping was conducted in warehouses containing 1,897,000 cubic feet of Turkish tobacco and 1,517,000 cubic feet of flue-cured tobacco. Because of a heavier infestation, more traps were used than in experiment 1. In the

Turkish storage warehouses 25 traps were operated from June 1 to November 13, and in the domestic storage warehouse 20 traps were operated from June 15 to November 13. One trap was operated for each 75,850 cubic feet of warehouse space. The numbers of beetles caught during this period are presented in table 2 and figures 7 and 8.

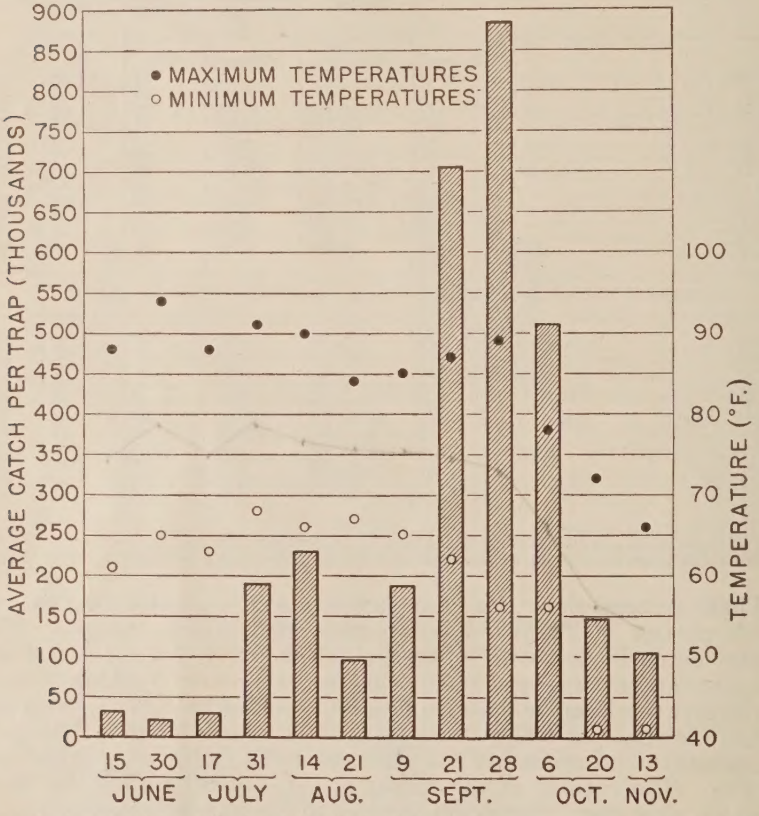

FIGURE 7.—Average catches of the cigarette beetle, in relation to the temperature and the season, in open-storage warehouses containing Turkish tobacco. Experiment 2.

These records again show that the population of cigarette beetles was much greater in Turkish than in domestic tobacco. The largest catch in Turkish tobacco, an average per trap of 884,000, was made during a 7-day interval, September 21 to 28. The largest catch in domestic tobacco, an average of 112,750 beetles per trap, was made during a 21-day interval, July 24 to August 14.

Here again it is apparent that temperature alone is not the controlling factor in beetle migrations. The peak of emergence of the spring brood occurred about June 15 in the Turkish tobacco warehouses, after an average maximum temperature of 88° F. for the 14-day period ended on this date. The largest catch was made during the 7-day period ended September 28, when the average maximum temperature was 89°. The average minimum temperature for the period ended June 15 was 61°, and for the period ended September 28 it was

56°. The cooler nights which often occur at the time of emergence of the spring brood may affect the migration of beetles, although this

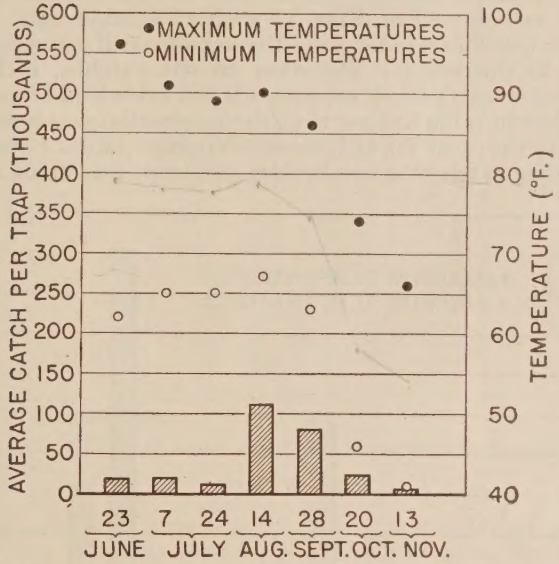

FIGURE 8.—Average catches of the cigarette beetle, in relation to the temperature and the season, in an open-storage warehouse containing domestic flue-cured tobacco. Experiment 2.

behavior is probably controlled to a greater extent by the season of the year.

TABLE 2.—*Cigarette beetles caught in open-storage warehouses filled with Turkish and domestic tobacco, in relation to temperature and season, experiment 2, 1933*

Date	Interval	Beetles caught		Temperature		
		Total	Average per trap	Average maximum	Average minimum	Mean
	Days	*Number*	*Number*	*°F.*	*°F.*	*°F.*
TURKISH TOBACCO WAREHOUSES—25 TRAPS STARTED ON JUNE 1[1]						
June 15	14	850,000	34,000	88	61	74.5
June 30	15	551,050	22,042	94	65	79.5
July 17	17	775,400	31,016	88	63	75.5
July 31	14	4,718,000	188,720	91	68	79.5
Aug. 14	14	5,760,000	230,400	90	66	78.0
Aug. 21	7	2,436,000	97,440	84	67	75.5
Sept. 9	19	4,709,500	188,380	85	65	75.0
Sept. 21	12	17,689,500	707,580	87	62	74.5
Sept. 28	7	22,100,000	884,000	89	56	72.5
Oct. 6	8	12,810,000	512,400	78	56	67.0
Oct. 20	14	3,720,000	148,800	72	41	56.5
Nov. 13	24	2,625,000	105,000	66	41	53.5
DOMESTIC TOBACCO WAREHOUSE—20 TRAPS STARTED ON JUNE 15[2]						
June 23	8	405,000	20,250	96	62	79.0
July 7	14	420,000	21,000	91	65	78.0
July 24	17	275,000	13,750	89	65	77.0
Aug. 14	21	2,255,000	112,750	90	67	78.5
Sept. 28	45	1,655,000	82,750	86	63	74.5
Oct. 20	22	500,000	25,000	74	46	60.0
Nov. 13	24	170,000	8,500	66	41	53.5

[1] These warehouses consisted of 5 sections having a total of 1,897,000 cubic feet of space.
[2] This warehouse consisted of 4 sections having a total of 1,517,000 cubic feet of space.

EXPERIMENT 3

For the third experiment traps were placed in 3,125,000 cubic feet of Turkish tobacco storage warehouses of the closed type. The experiment was started on May 12 with 11 suction light traps, and this number was increased during the season until a maximum of 64 traps were in operation. The data on the catches, including the temperature for each period, are presented in table 3 and figure 9.

The catches in table 3 show that the infestation was heavier in the closed than in the open Turkish-tobacco storage (tables 1 and 2). The largest average catch, 954,619 beetles per trap, was made during the

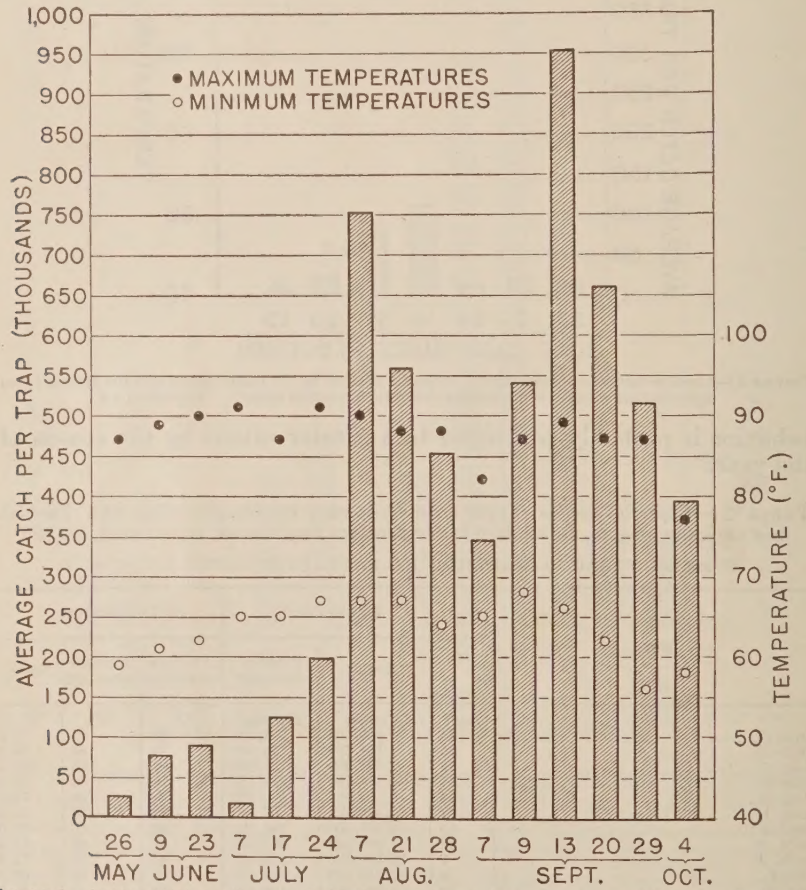

FIGURE 9.—Average catches of the cigarette beetle, in relation to the temperature and the season, in closed-storage warehouses containing Turkish tobacco. Experiment 3.

interval September 9 to 13. During this period 64 traps were operated, or 1 trap for every 48,828 cubic feet. The graph in figure 9 again indicates that beetle migration is seasonal. The largest catch of the spring brood, 90,136 per trap, was made during the 14-day period June 9 to 23, with an average maximum temperature of 90° and an average minimum of 62° F. The largest catch was made September 9 to 13, during the emergence of the third brood, with the average maximum temperature 89° and the average minimum 66°.

TABLE 3.—*Cigarette beetles caught in closed-storage warehouses[1] filled with Turkish tobacco, in relation to temperature and season, experiment 3, 1933*

Date	Interval	Traps	Beetles caught		Temperature		
			Total	Average per trap	Average maximum	Average minimum	Mean
	Days	*Number*	*Number*	*Number*	°*F.*	°*F.*	°*F.*
May 26	[2] 14	11	300, 400	27, 309	87	59	73.0
June 9	14	40	3, 134, 900	78, 373	89	61	75.0
June 23	14	40	3, 605, 450	90, 136	90	62	76.0
July 7	14	40	776, 660	19, 415	91	65	78.0
July 17	10	40	5, 050, 000	126, 250	87	65	76.0
July 24	7	55	10, 958, 000	199, 236	91	67	79.0
Aug. 7	14	57	42, 942, 000	753, 368	90	67	78.5
Aug. 21	14	55	30, 758, 000	559, 236	88	67	77.5
Aug. 28	7	55	24, 961, 000	453, 836	88	64	76.0
Sept. 7	10	58	20, 042, 800	345, 556	82	65	73.5
Sept. 9	2	59	31, 923, 050	541, 069	87	68	77.5
Sept. 13	4	64	61, 095, 600	954, 619	89	66	77.5
Sept. 20	7	60	39, 625, 000	660, 417	87	62	74.5
Sept. 29	9	60	31, 096, 550	518, 276	87	56	71.5
Oct. 4 [3]	5	60	23, 693, 900	394, 898	77	58	67.5

[1] Total space, 3,125,000 cubic feet.
[2] Traps started on May 12.
[3] The experiment was terminated on Oct. 4, because the warehouses were fumigated with hydrocyanic acid gas on this date.

SEX RATIOS

The writers have been unable to find any external characters on adults of the cigarette beetle by which males can be distinguished from females. During the summer of 1932 a method for determining sex ratios in samples of beetles taken from the traps was developed.[4] The beetles were soaked overnight in a 10-percent solution of potassium hydroxide, and were than placed in a small glass dish containing glycerin. The bodies of the beetles were sufficiently cleared by this treatment to reveal the genitalia when examined under the binocular microscope. After becoming more familiar with the anatomy of the beetles, the writers found it practicable to place the specimens in glycerin and dissect them under the binocular microscope. In the experiments conducted in 1932, 5,878 beetles were examined in this manner, and 2,150, or 36.6 percent, were males, while 3,728, or 63.4 percent, were females. During 1933, of 1,140 beetles examined, 497, or 43.6 percent, were males and 643, or 56.4 percent, were females.

EGGS IN BODIES OF TRAPPED FEMALES

On August 10 a sample containing 110 female cigarette beetles was collected from a trap that had been in operation 16 hours, and the beetles were dissected. An average of only 4.4 eggs per female was found. Because of this small number, it was decided to make other dissections at varying intervals. Another sample of 110 females was dissected on August 21, after the trap had been in operation for 36 hours. An average of 8.5 eggs per female was found. On September 6, 3 samples of 10 females each were taken from a trap at intervals of 1, 2, and 12 hours, respectively. A marked increase in the average number of eggs per female was found in these samples, as follows: 21.3 after 1 hour, 22.3 after 2 hours, and 19.7 after 12 hours. Crowding of the beetles in the glass jar attached to the trap apparently causes females to deposit most of their mature eggs.

[4] The writers wish to acknowledge the work of C. W. Kearns, field aid at the Tobacco Insect Laboratory during the summers of 1932 and 1933, in developing this method.

INEFFECTIVENESS OF THE TRAP AGAINST THE TOBACCO MOTH

The traps lighted with the mill-type bulbs proved ineffective against the tobacco moth (*Ephestia elutella* Hbn.). The catches of adults were small in warehouses that contained heavy infestations of this moth. From a comparison between the catches made of cigarette beetles and tobacco moths, shown in table 4, it is seen that catches of the tobacco moth were almost negligible in relation to catches of the cigarette beetle. The records of the moths caught throughout the trapping experiments are available, but since the catches were small it is believed that the data given in table 4 are sufficient to show that the suction light trap is ineffective against the tobacco moth. Further experiments are being conducted in an effort to develop a trap that will be effective against this insect.

TABLE 4.—*Comparison of catches of the cigarette beetle and the tobacco moth made in the suction light trap in tobacco warehouses, 1933* [1]

Date	Interval	Cigarette beetles		Tobacco moths	
		Total	Average per trap	Total	Average per trap
	Days	*Number*	*Number*	*Number*	*Number*
May 26	11	7,750	775	252	25
June 9	14	37,875	3,787	2,450	245
June 16	7	107,200	10,720	475	47
June 23	7	303,000	30,300	217	22
July 3	10	205,300	20,530	226	23
July 7	4	14,685	1,468	132	13
July 14	7	35,082	3,508	159	16

[1] 5 sections were trapped, each containing 221,000 cubic feet. Total area trapped, 1,105,000 cubic feet, or 1 trap for each 110,500 cubic feet.

BENEFITS TO BE DERIVED FROM TRAPPING

The suction light trap is a promising device for use in open-storage warehouses, where fumigation is impossible. It is believed that the catching of such large numbers of cigarette beetles as shown in tables 1 to 3, inclusive, will materially reduce the number of insects in stores of tobacco. Experiments are being continued, however, to determine the actual value of the trap for insect control in open storages.

Cigarette-type tobaccos are stored from 2 to 4 years, and in some instances more than 4 years, prior to manufacture. During this storage period the tobacco goes through a number of fermentations called "sweats," and it is said to be "aged" when withdrawn for manufacture. On account of the frequent withdrawal of "aged" tobaccos it is difficult to evaluate the benefits of trapping in warehouses from one season to another. Experiments have been outlined whereby warehouses will be filled with new-crop tobacco only and none withdrawn during the storage period, in order that the results of these large catches on the infestation of the next season may be determined.

SUMMARY

Because of the large quantities of cigarette-type tobaccos stored in open-storage warehouses in the Bright Tobacco Belt, and since this type of warehouse has never been fumigated effectively, other methods of controlling the cigarette beetle (*Lasioderma serricorne* Fab.) have

been sought. The results obtained from the use of the suction light trap have been encouraging, and a progress report of trapping experiments is given.

The trap consists of a sheet-metal barrel, a reflector of block tin, and a wire cone to which is attached a 1-quart glass jar for collecting the insects. A crossbar, to which is attached a $\frac{1}{20}$-horsepower motor, is riveted in the barrel, and two fan blades, which provide suction through the trap, are connected with the motor. These traps may be constructed by local sheet-metal workers from a blueprint or model at a total cost of about $20 per trap (based on 1934 prices in Virginia and North Carolina).

The light that has been found to be most satisfactory for use in the trap is the 50-watt "mill-type" or rough-service bulb.

Three trapping experiments were conducted in 1933. Experiment 1 included 1,105,000 cubic feet of open-storage warehouses containing Turkish tobacco and 4,199,000 cubic feet of the same type of warehouses containing domestic flue-cured tobacco. One suction light trap was operated for each 110,500 cubic feet of storage space. Experiment 2 included 1,897,000 cubic feet of open-storage Turkish tobacco warehouses and 1,517,000 cubic feet of open-storage warehouse filled with domestic flue-cured tobacco. A suction light trap was operated for each 75,850 cubic feet of warehouse space. In both experiments it was demonstrated that Turkish tobacco was more heavily infested by the cigarette beetle than domestic tobacco, and that the migration of this insect is influenced both by temperature and the season of the year.

Experiment 3 included 3,125,000 cubic feet of Turkish-tobacco storage of the closed type. Trap records show a greater population of the cigarette beetle in closed than in open storages. The largest average catch of beetles, 954,619 per trap, was made during the 4-day period September 9 to 13, when one trap was used for each 48,828 cubic feet of storage space.

During 1932 and 1933 samples of trapped cigarette beetles were dissected in order to determine sex ratios. In 1932, of the 5,878 beetles dissected, 36.6 percent were males and 63.4 percent were females. In 1933, of the 1,140 beetles examined, 43.6 percent were males and 56.4 percent were females.

The suction light trap is not effective against the tobacco moth (*Ephestia elutella* Hbn.).

The suction light trap is a promising device for use in controlling the cigarette beetle in open-storage warehouses. The large catches of insects obtained in the experiments indicate that the population of these insects in tobacco warehouses can be materially reduced with these traps.

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